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NASA TECH BRIEF

Study of Hot Wire Techniques in Low Density Flows with High Turbulence Levels

Large turbulence levels in the separation and reattachment regions of free shear layers produce severe heat fluxes that emphasize the urgent need for a technique that will allow an experimental determination of turbulent properties. The prediction of heat, mass, species, and momentum fluxes in a space vehicle and a more detailed understanding of aerodynamic noise production by supersonic jet and rocket exhausts require a predictability of the associated turbulence fields.

Flow phenomena and heat transfer have been studied behind a blunt trailing edge in a two-dimensional, supersonic shear with a turbulent forebody boundary layer.

To date, the hot wire is the only instrument that has been applied successfully to turbulence investigated in shear layers. The proposed measurements are, however, unusual since the rms levels in the recirculation zones of interest might very well be so large that they are comparable to the mean value.

A review of hot-wire heat loss equations indicates that a time invariant frequency response can be obtained at high turbulence levels only if the probes are operated at a constant temperature. The static calibration of two modern constant-temperature hot-wire systems combined with hot-wire and hot-film sensors was used. The two systems were a modified Kovasznay circuit and the DISA anemometer. These calibrations showed significant changes at low densities approaching one percent of atmosphere. Also, there was a large increase of wall proximity effects at low densities. At a pressure of approximately 0.1 atmosphere, the effect of a wall at room temperature is detectable at approximately 1000 hot-wire radii.

Considerable changes were found to occur in the slope of the wire resistance temperature relation. This is especially true at low temperatures. These changes are attributed to impurities and results of the mechanical drawing process which make it necessary to repeat the resistance-temperature calibration for each consignment of wire.

A summary of the extensive static and dynamic calibrations of modern hot-wire systems that might be used in low density flows with high relative fluctuation levels is contained in a technical report, "Hot Wire Techniques in Low Density Flows with High Turbulence Levels," by A. R. Hanson and R. E. Larson of Litton Systems, Inc., and F. R. Krause of Marshall Space Flight Center. The report is available from:

Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
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Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: A. R. Hanson, R. E. Larson
of Litton Systems
F. R. Krause
of Marshall Space Flight Center
(M-FS-1269)

Category 01